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E7.4-10168

CR-136295

EFFECTS OF CONSTRUCTION AND STAGED FILLING
OF RESERVOIRS ON THE ENVIRONMENT AND ECOLOGY

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E74-10168) EFFECTS OF CONSTRUCTION AND STAGED FILLING OF RESERVOIRS ON THE ENVIRONMENT AND ECOLOGY Progress Report, 9 Jun. - (Army Construction Engineering Research Lab) 20 21 p HC \$3 25 CSCL 08H G3/13 00168
N74-14036
Unclas

Date: 8 December 1973

Type II Progress Report for period 9 June 1973 -
8 December 1973 (ERTS-1)

Prepared for:

Goddard Space Flight Center (GSFC)
Greenbelt, Maryland 20771

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TYPE II PROGRESS REPORT (For the period 9 June 1973 - 8 December 1973)

TITLE: Effect of Construction and Staged Filling of Reservoirs
on the Environment and Ecology MMC #341

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GSFC ID NUMBER: DE 335

OBJECTIVE:

To study the environmental and ecological impact of the construction and operation of Springer-Sangamon Reservoir and Friends Creek Impoundment located on the Sangamon River in East Central Illinois.

INTRODUCTION:

During this report period most of the research effort was directed to the development of an operational interpretation system for the project. (As was stated in previous reports there is some doubt the reservoirs will be constructed during the lifetime of this ERTS-1 contract. To date, the major emphasis of this investigation has been centered on the development of the technical procedures for the enhancement and analysis of the ERTS imagery to meet the original objectives of the study.)

The four basic components of the interpretation system will be discussed in detail in this report. The equipment used in the system will also be discussed and illustrated. Some examples of selected outputs are included.

Ground truth data acquisition has been primarily directed to complete a vegetative inventory within the corridor of the Sangamon River between Mahomet and Decatur, Illinois. Other ground data is being collected at selected sampling sites or at transect plots located within the river corridor.

REPORT:

The operational interpretation system developed by personnel at the University of Illinois for this project is almost complete. The interpretation system is basically an optical processing system which allows for interface to digital analysis. It is simple, inexpensive, and easy to use. The basic components of the system are shown in Fig. 1 and are briefly discussed below. Additional components of the Display subsystem and the Interpretation and Mapping subsystem are currently being tested and may be added in the future.

Optical Processing

Macrophotography. The majority of the identification and interpretation of ERTS and SKYLAB imageries requires considerable magnification of the original print or transparency. A Mamiya RB-67 camera capable of close-up work (0.5X) and a Miranda FVT camera with bellows and macro lens for 1X→10X magnification are used. Most straight copying is done using Eastman Kodak color negative #5254 film for transparencies and Ektacolor-S film for prints. An Aristo DA-110 daylight source is used for copying prints on Ektacolor-S film and 3400°K lighting is used for the 5254 film. An extremely rigid Saturn copying stand is used.

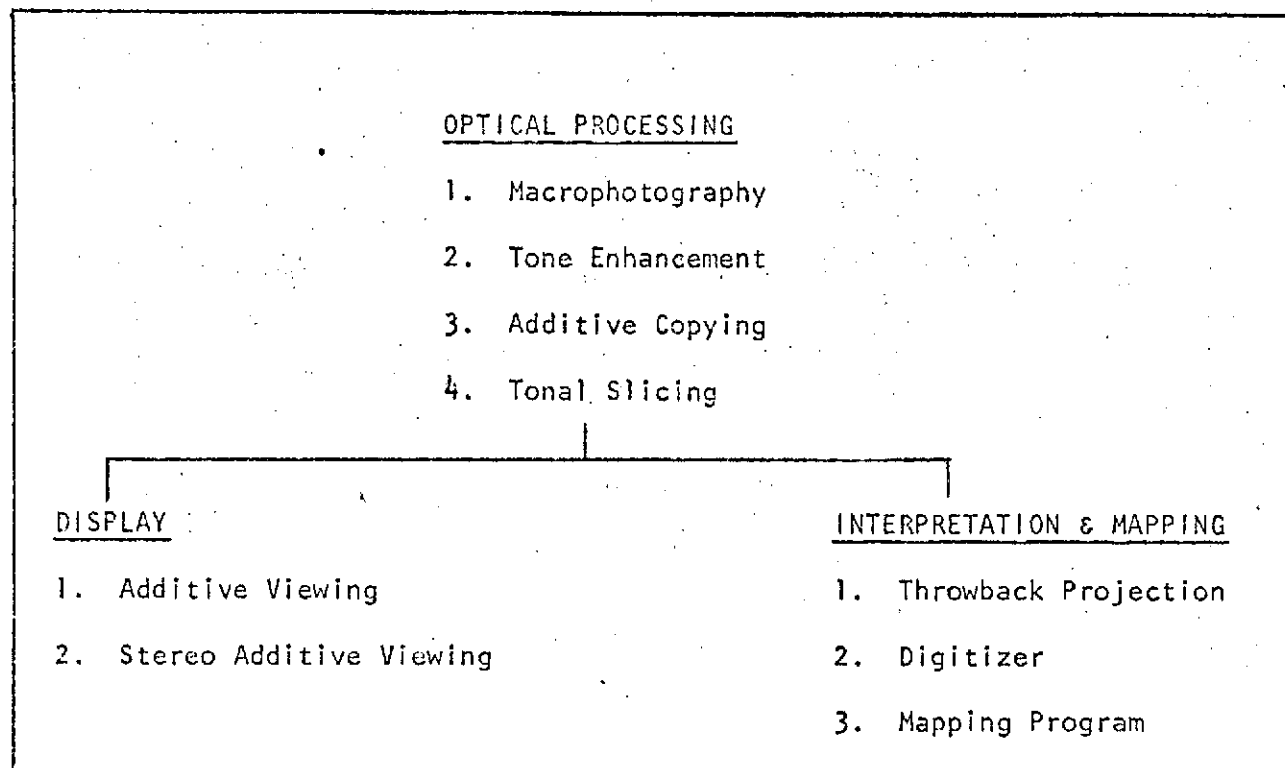


Figure 1. Basic Components of the Interpretation System

Tone Enhancement. Simple tone enhancement using Eastman Kodak high contrast Photomicrography color film #2483 has proven to be highly satisfactory. Fig. 2 is an RC Ektachrome print of a 5254 transparency (normal color rendition) of the Decatur, Illinois area. Figure 3 is a photomicrography film rendition of the same area. Using the photomicrography film in conjunction with a throwback projection system provides an effective procedure for interpreting small portions of ERTS imagery. Copying SKYLAB imagery with this film proved to be not as useful as with the ERTS imagery. Due to the near monochrome rendition of the regular color film used in the Earth Terrain Camera, the copy on photomicrography film was almost of a single hue. However, slight tonal differences are enhanced and the high contrast image causes a considerable improvement in the identification of features, based on the spatial rather than the spectral characteristics of the scene.

Additive Copying. Experiments are underway using Mamiya RB-67 camera and 120 Ektacolor-S film. Triple exposures are made of the three (MSS4, MSS5, MSS7) black/white imageries from ERTS. Through the use of appropriate filters, an infrared color rendition or other color combinations are obtained.

Tonal Slicing. Initial experiments are currently underway using 1:1 photo copies of the MSS4, MSS5 and MSS7 black/white pictures onto ortho type-3 materials for tonal slicing. The slices are then copied additively for a color rendition. Results of preliminary experiments look promising.



Figure 2. Regular Color ERTS Imagery

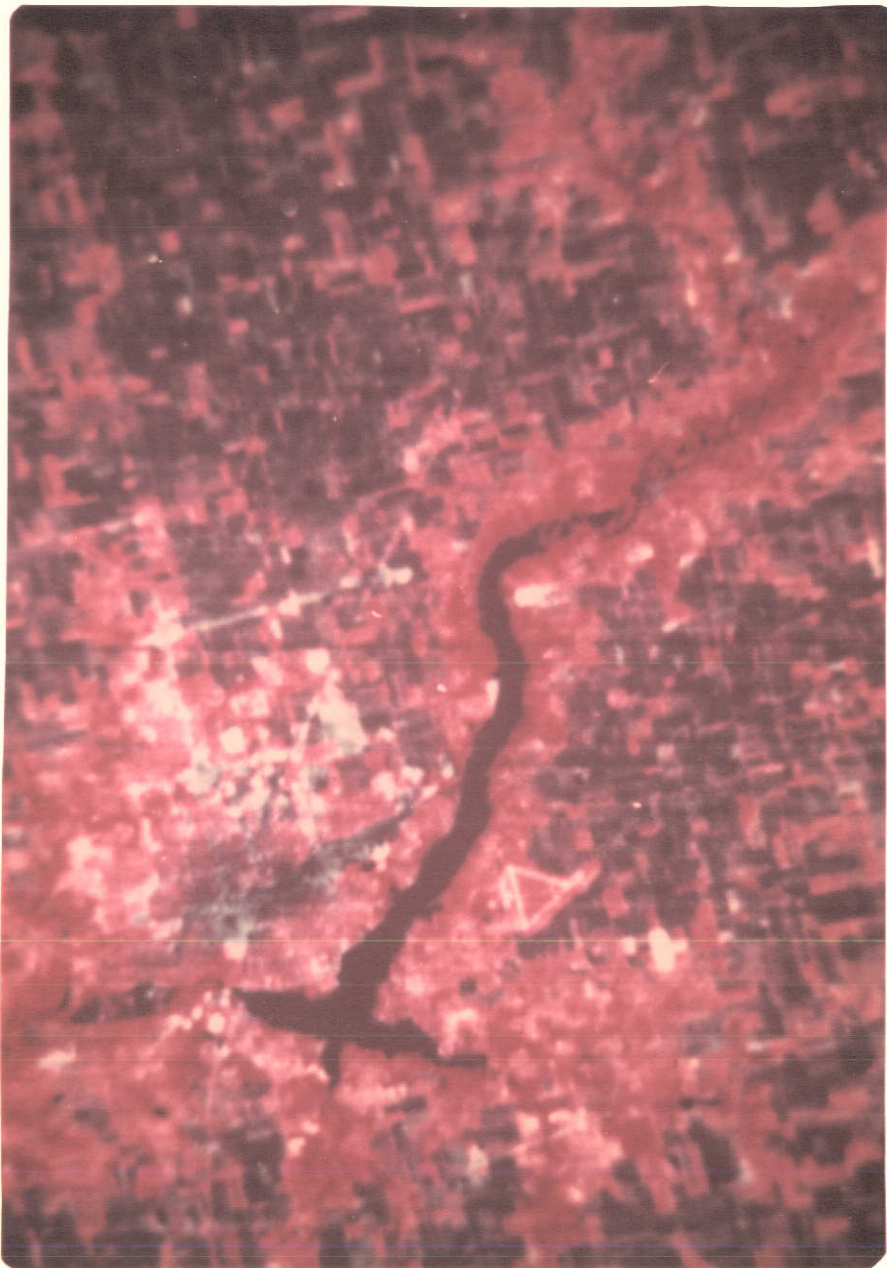


Figure 3. Photomicrography Copy of the ERTS Imagery Shown in Figure 1

Display

A relatively simple additive viewer has been designed to realize real-time enhancement from ERTS 70 mm film. This system uses two projectors with a primary color filter for one band and the complement of the primary filter for the other band. Coincidence of images is maintained by a beam-splitting mirror (Fig. 4). Although only two bands are used (always MSS7 and one of the visible bands: MSS4 or MSS5), the results are excellent. Perfect image registration is maintained and the use of the two bands allows for fast set-up. No apparent loss of information is observed in the resulting images. The two visible bands can also be combined into a single black/white positive composite to be used for projection with the MSS7 band. The simple additive viewer can be extended for use with three bands by adding another projector and beam splitter (Fig. 4). This has been done with little improvement of the resultant image over that produced by two band images.

Interpretation and Mapping

A simple interpretation system was developed, based on the previously discussed 35 mm slide copying system. A projection system was built to allow imaging of the contents of the slide on a sheet of paper supported on glass (Fig. 5). A grid was developed compatible with the line printer dimensions for the computer lister sheet. With enlarged images, tonal mapping is accomplished by striking a line through the grid cells occupied by a particular tonal class (Fig. 6). The digitized results are entered into a computer mapping program which displays all tonal classes or

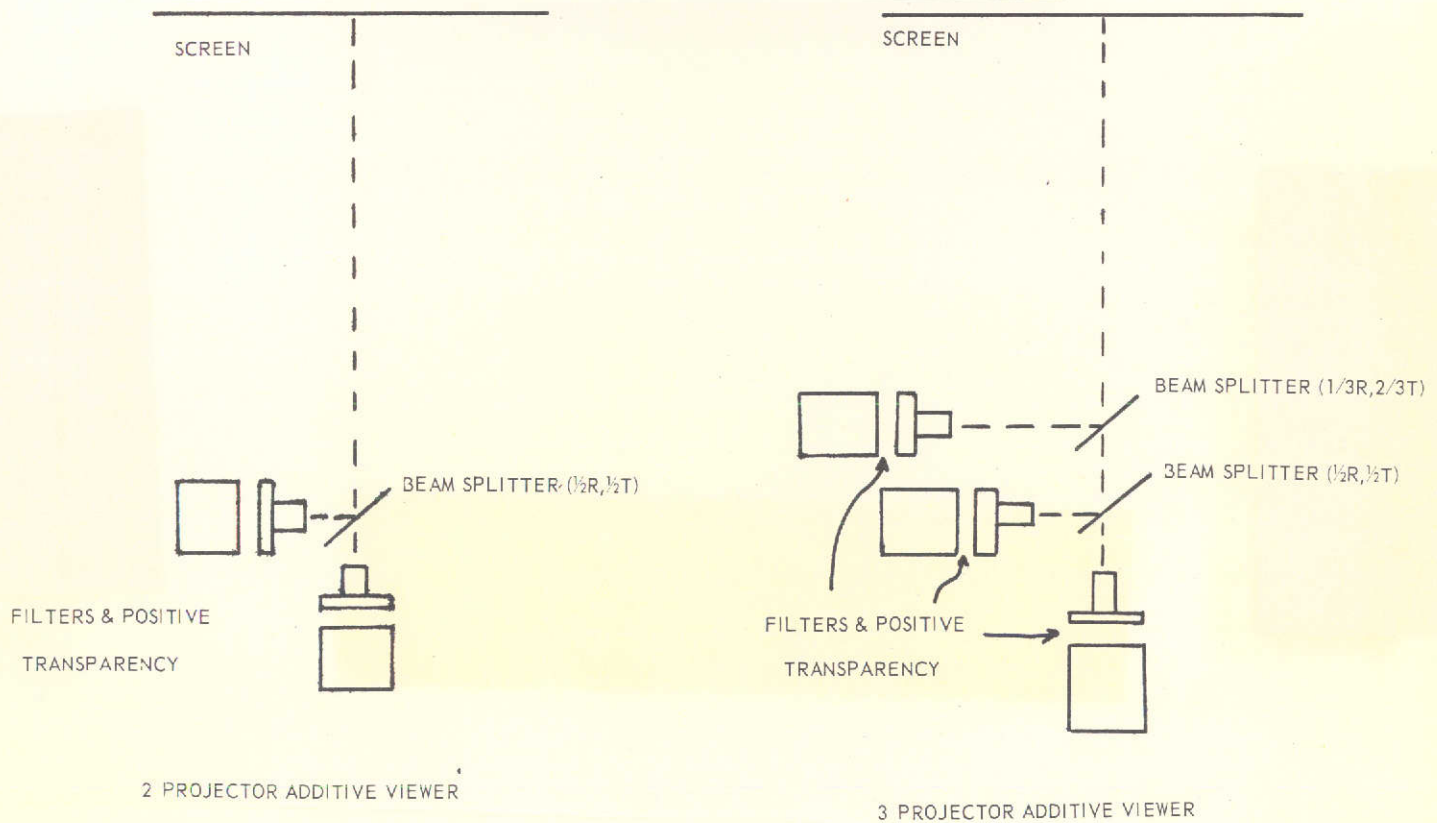


Figure 4. Additive Viewing

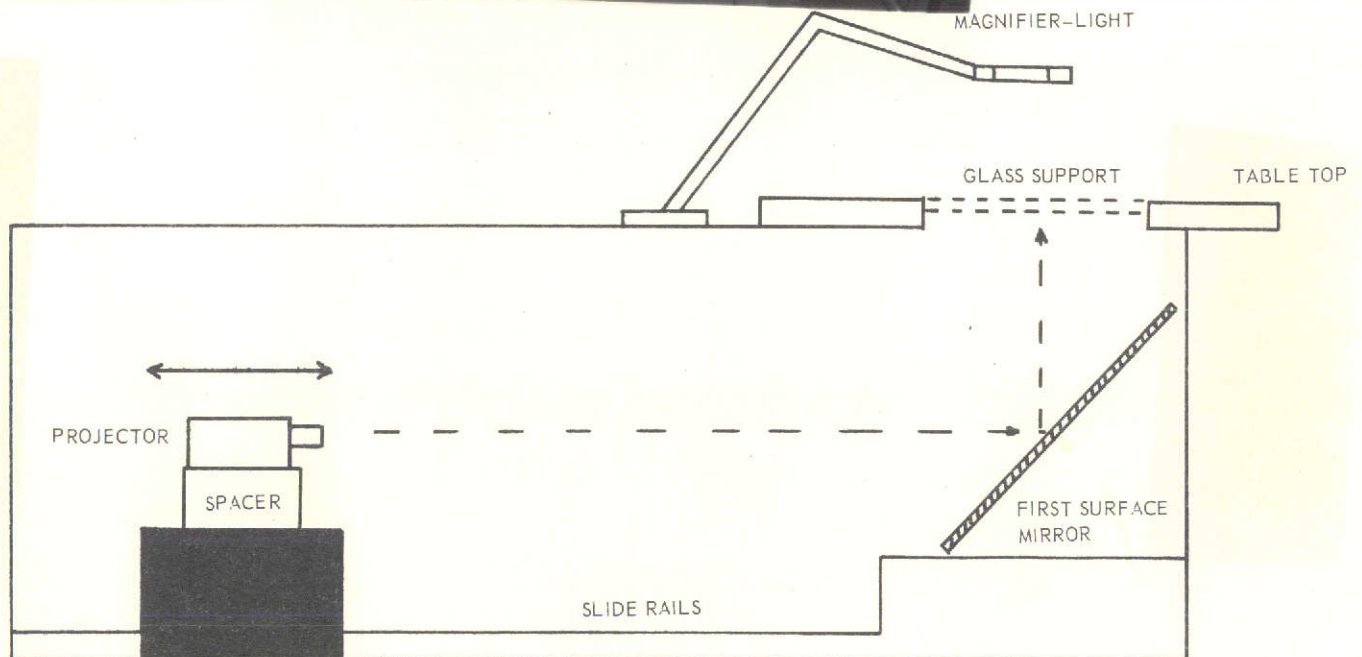


Figure 5. Throwback Projector

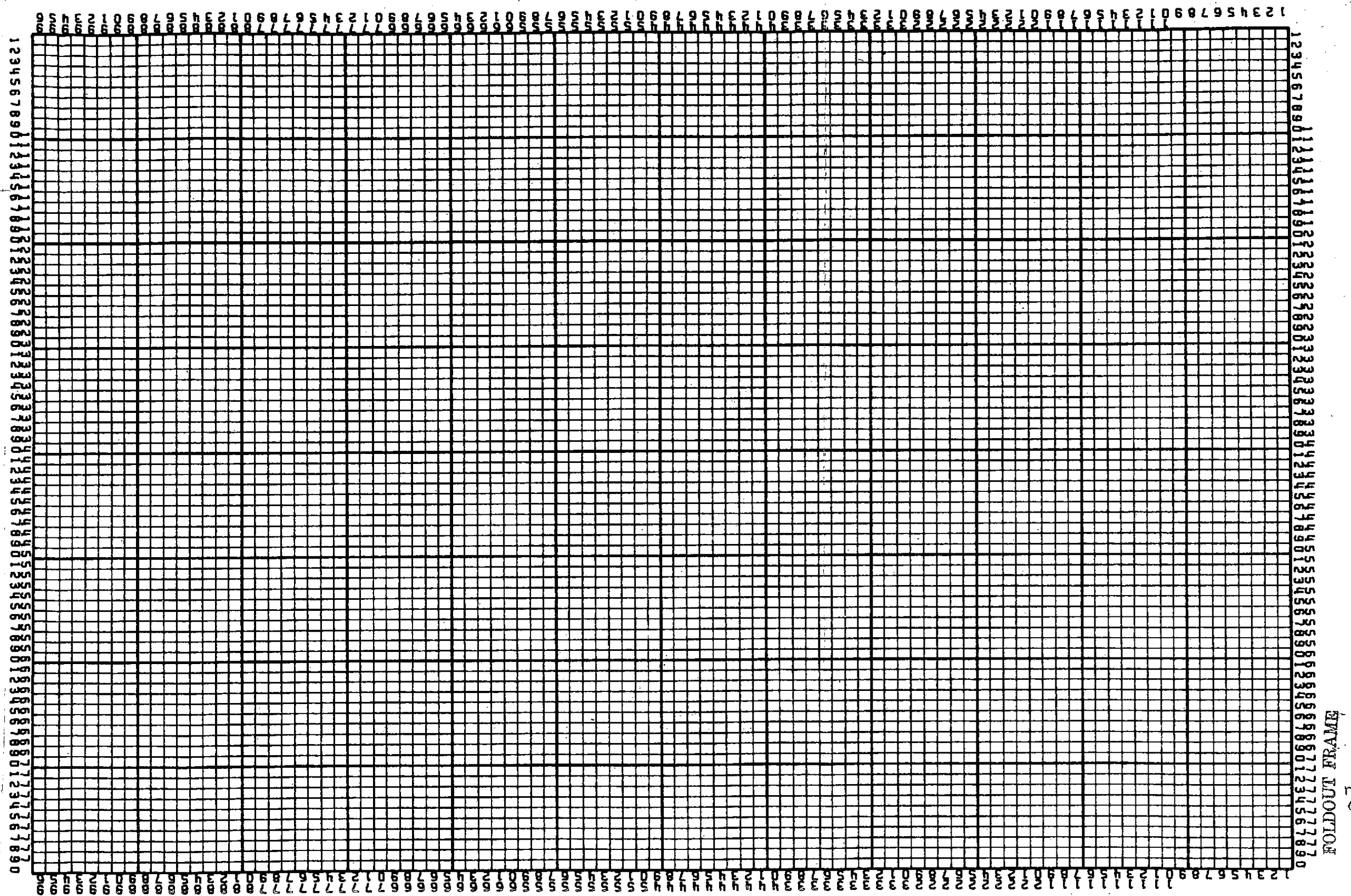


Figure 6. Digital Coding Sheet

FOLDOUT FRAME

10

FOLDOUT FRAME

combination of classes. Overlays from the same image digitized for different times is allowed. Difference maps or combined class maps can then be produced. The computer program is currently about 75 percent complete and is similar to but more flexible than the Harvard SYMAP program used previously. Eventually, the output will be produced by a CalComp program for increased accuracy and will be able to include mapped boundaries of water bodies, roads, etc., derived from the photogrammetric models.

This system is also used for mapping underflight information. Figures 7 and 8 show typical output from ERTS and Underflight imageries. Figure 7 is the interpretation of the image shown in Fig. 3 and Fig. 8 is the interpretation of an enlarged section of the Decatur, Illinois frame of the underflight photography shown in Fig. 9. This area is outlined by the rectangle shown in Fig. 7-a.

Surface Configuration

Experiments designed to indicate surface characteristics and examine the geometric properties of the ground surface from SKYLAB, Underflight and the 1:12000 color photography flown by Sidwell Studios in June 1973 are underway. The experiments are in three parts: planimetric mapping, photogrammetric three-dimensional mapping, and analysis of surface configuration.

Planimetric Mapping

Detailed planimetric mapping is being produced photogrammetrically from ERTS, SKYLAB, Underflights and the 1:12000 color photography, in an

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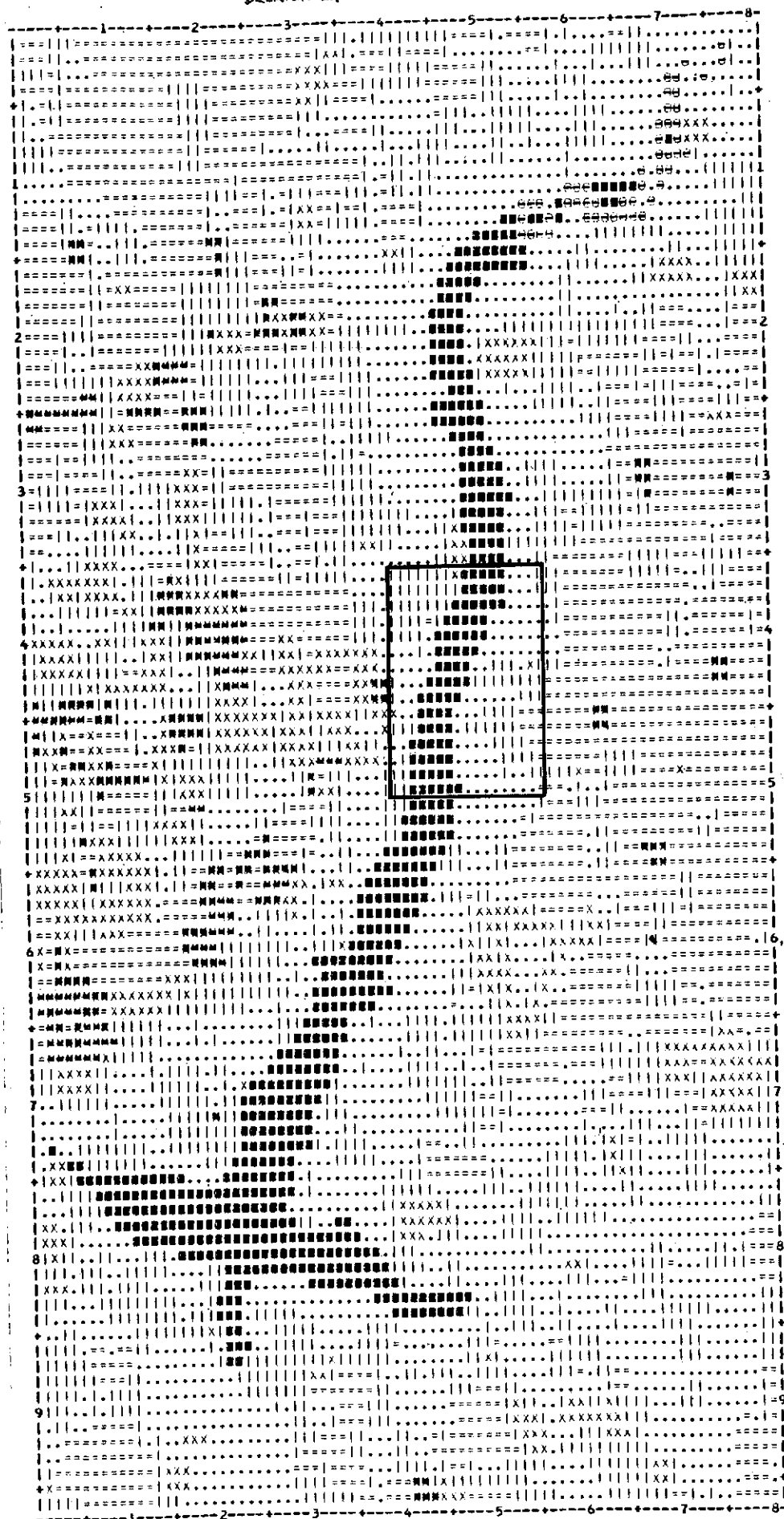


Figure 7-a. Interpretation of ERTS Imagery of the Decatur, Illinois Area

	LEVEL	SYMBOL	VALUE	FREQUENCY	LABEL
VEGETATION 1	1)	I.....I	1.00	2225.00	RED
BARE SOIL	2)	I=====I	2.00	1997.00	GREEN
VEGETATION 2	3)	I I	3.00	2032.00	GREY
CONCRETE	4)	IXXXXXXI	4.00	427.00	YELLOW
WATER	5)	I#####I	5.00	567.00	BLUE
VEGETATION 3	6)	I#####I	6.00	50.00	PURPLE
URBAN 1	7)	I#####I	7.00	85.00	ORANGE
URBAN 2	8)	I#####I	8.00	166.00	BROWN
URBAN 3	9)	IXXXXXXI	9.00	131.00	BLACK

Figure 7-b. Key for Figure 7-a

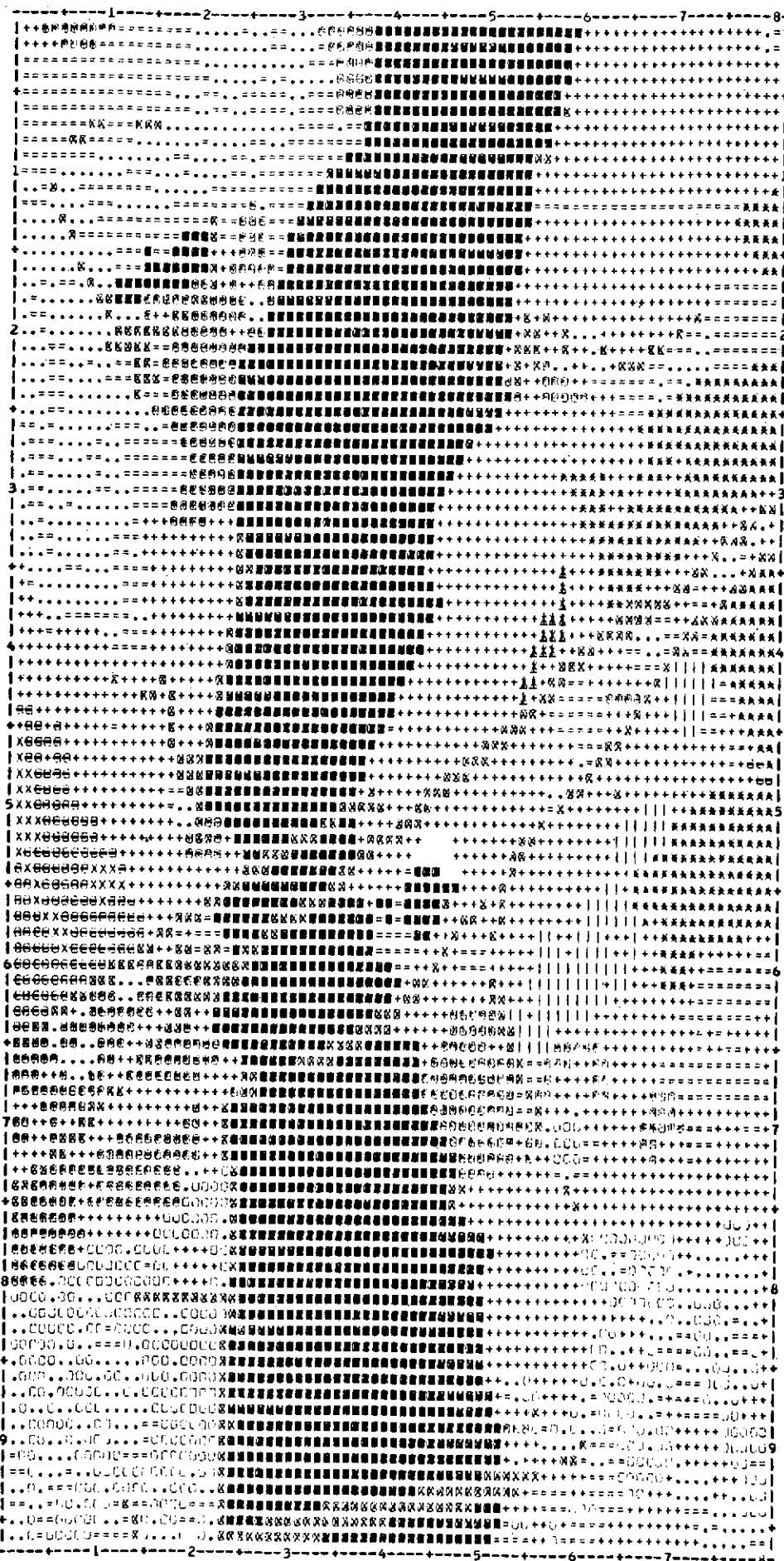


Figure 8-a. Interpretation of an Underflight Imagery of the Decatur, Illinois Area

	LEVEL	SYMBOL	VALUE	FREQUENCY	LABEL
VEGETATION 1	1)	I.....I I.....I I.....I	1.00	619.00	RED
VEGETATION 2	2)	I+++++I I+++++I I+++++I	2.00	2153.00	OLIVE
VEGETATION 3	3)	I=====I I=====I I=====I	3.00	781.00	GREY
CROP 1	4)	I I I I I I	4.00	109.00	YELLOW
WATER	5)	I#####I I#####I I#####I	5.00	2069.00	BLUE
RESIDENTIAL	6)	I000000I I001000I I000000I	6.00	429.00	PURPLE
CROP 2	7)	I*****I I*****I I*****I	7.00	378.00	ORANGE
INDUSTRIAL 1	8)	I555555I I555555I I555555I	8.00	144.00	BROWN
TRANSPORTATION LINES	9)	I888888I I888888I I888888I	9.00	457.00	BLACK
VEGETATION 4	10)	I999999I I999999I I999999I	10.00	490.00	LIGHT GREEN
OPEN GROUND	11)	I I I I I I	11.00	16.00	DARK GREEN
INDUSTRIAL 2	12)	IXXXXXXI IXXXXXXI IXXXXXXI	12.00	31.00	LIGHT BLUE

Figure 8-b. Key for Figure 8-a



Figure 9. Enlargement of a Section of the Decatur, Illinois
Frame of the Underflight Imagery

effort to assess the accuracy and sensitivity of identifying cultural features for the test area. This test may be extended to assess accuracy and sensitivity of detecting changes in boundaries of cultural features, e.g., urban development, changes in transportation systems.

Photogrammetric Three-Dimensional Mapping

Spatial coordinates of points will be used to derive analytical digital terrain models for the test site from SKYLAB, Underflight, and the 1:12000 color photography. The complete SKYLAB model and related sample sites from the Underflight and the 1:12000 imageries will be used. Topographic map outputs will be made at this stage, and a sensitivity study among the outputs of the three types of imagery will be conducted. Currently, work on Underflight imagery is underway. The computer program to be used in this phase is complete and operational.

Analysis of Surface Configuration

Analysis of surface configuration will be undertaken and a sensitivity study made between the three types of imagery (SKYLAB, Underflight, and the 1:12000) for accuracy. In addition, information useful to environmental change detection will be extracted from the digital terrain models. Parameters such as slope, shape, roughness, volumes, etc., are outputted through the computer program. Full details about this computer program will be included in the final report of this project in June 1975.

Ground Truth

Correlation to ground truth is planned to start shortly. Preliminary mapping and statistical computer programs are being developed to compare the tonal interpretations with the collected field data. Emphasis is expected to be placed on vegetation distribution and water turbidity measures in Lake Decatur. The other six parameters (micro-climatology, stream conditions, groundwater, flood plain silt accumulation, inventory of insects, animal life inventory) will be considered at a later date.

Change Detection

Change detection capability at the present time is in the formulation stage. This capability is being introduced into the mapping program used in the interpretation system. Furthermore, a real-time change detection system using the simple additive viewer previously discussed is currently under development. Development and testing of these systems awaits the correlation of ground truth to the imagery.

Since no dam (major construction) is expected during the lifetime of this contract, suitable alternatives will be investigated to test the system. However, it may be questionable whether a suitable alternative can be found to test the environmental changes incurred by major construction.

Plans For Next Six Months

The above-mentioned interpretation system is expected to be completed. This will include the complete mapping of the river basin, correlation

to ground truth data, sensitivity checks of the ERTS imagery to SKYLAB, Underflight, and the 1:12000 imageries. The photogrammetric mapping and digital compilation will be continued and initial analysis of surface configuration will be undertaken.

Concluding Remarks

The personnel in the Geography and Civil Engineering Departments at the University of Illinois have done a fine job in developing this system for the project.

NASA personnel at GSFC, MSC, and the Ames Research Center have done an excellent job in supplying CERL with ERTS-1, SKYLAB, and U-2 products.

As the work on this project progresses, it is felt other users of remote sensing data, who require a simple, inexpensive and effective interpretation system, will benefit from the basic ideas used in the system developed for this project. It should be noted this system is intended for low-volume and/or single shot operations. Such a system would satisfy the needs of a large portion of the user community whose objectives could be met by analyzing a small number of images.